CLAIMS:

1. A method of serially transferring annihilation information in a compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body, comprising the steps of:

inputting a first time pulse on a first channel, the first channel being one of a plurality of channels, the first time pulse comprising a position representing a time-of-occurrence of a first annihilation event;

generating a first time signal, the first time signal representing a time-of-occurrence of the first time pulse, the first time pulse being asynchronous to a clock signal;

generating a first address signal, the first address signal comprising a first address, the first address representing the first channel, the first address signal being synchronous to the clock signal;

generating a first channel signal, the first channel signal comprising the first time signal and the first address signal; and

outputting the first channel signal serially.

2. A method of transferring annihilation information in a compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body, as defined by Claim 1, further comprising the steps of:

inputting a second time pulse on a second channel, the second channel being one of the plurality of channels, the second time pulse comprising a position representing a time-of-occurrence of a second annihilation event;

generating a second time signal, the second time signal representing a time-of-occurrence of the second time pulse, the second time pulse being asynchronous to the clock signal;

generating a second address signal, the second address signal comprising a second address, the second address representing the second channel, the second address signal being synchronous to the clock signal;

generating a second channel signal, the second channel signal comprising the second time signal and the second address signal;

generating a composite signal, the composite signal comprising the first channel signal and the second channel signal; and

outputting the composite signal serially.

3. A method of transferring annihilation information in a compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body, as defined by Claim 1, further comprising the step of adapting the method for use in obtaining the input function from at least one of a human wrist, head, neck, arm, and leg.

4. A method of transferring annihilation information in a compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body, as defined by Claim 1, further comprising the steps of:

inputting first energy information on the first channel, the first energy information representing an energy content of the first annihilation event;

generating a first energy signal, the first energy signal comprising a first energy pulse, the first energy pulse comprising a position representing the first energy information, the first energy pulse being asynchronous to the clock signal; and

incorporating the first energy signal in the first channel signal.

5. A method of transferring annihilation information in a compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body, as defined by Claim 2, further comprising the steps of:

inputting second energy information on the second channel, the second energy information representing an energy content of the second annihilation event;

generating a second energy signal, the second energy signal comprising a second energy pulse, the second energy pulse comprising a position representing the second energy information, the second energy pulse being asynchronous to the clock signal; and

incorporating the second energy signal in the second channel signal.

6. A method of transferring annihilation information in a compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body, as defined by Claim 1, further comprising the step of incorporating a synchronous delay between the first time signal and the first address signal.

7. A method for serially transferring annihilation information in a compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body, as defined by Claim 1, wherein the first channel signal comprises a first packet, the first packet comprising information representing the first time signal and the first address signal, the method further comprising the

step of determining a duration of the packet T_{packet} in accordance with the following equation:

$$T_{packet} = (\log_2(N) + 2) * T_{clock} \quad (1),$$

N representing the number of channels, T_{clock} representing a period of the clock signal.

8. A method of transferring annihilation information in a compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body, as defined by Claim 1, wherein the first channel signal comprises a first packet, the first packet comprising information representing the first time signal and the first address signal, the method further comprising the step of determining a duration of the packet T_{packet} in accordance with the following equation:

$$T_{packet} \langle\langle 1/(N * rate) \quad (2),$$

N representing the number of channels, *rate* representing an average rate of annihilation events per channel.

9. A method of serially transferring annihilation information in a compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body, as defined by Claim 1, further comprising the steps of:

inputting a second time pulse on a second channel, the second channel being one of the plurality of channels, the second time pulse comprising a position representing a time-of-occurrence of a second annihilation event, the time-of-occurrence of the first annihilation event being substantially the same as the time-of-occurrence of the second annihilation event; and

disregarding one of the first annihilation event and the second annihilation event in accordance with a priority scheme.

10. A method of serially transferring annihilation information in a compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body, as defined by Claim 1, further comprising the steps of:

inputting a second time pulse on a second channel, the second channel being one of the plurality of channels, the second time pulse comprising a position representing a time-of-occurrence of a second annihilation event, the time-of-occurrence of the first annihilation event being substantially the same as the time-of-occurrence of the second annihilation event; and

disregarding one of the first annihilation event and the second annihilation event associated with a lower channel address.

11. An apparatus to serially transfer annihilation information in a compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body, the apparatus comprising:

a first time signal generator, the first time signal generator inputting a first time pulse on a first channel, the first channel being one of a plurality of channels, the first time pulse comprising a position representing a time-of-occurrence of a first annihilation event, the first time signal generator generating a first time signal, the first time signal representing a time-of-occurrence of the first time pulse, the first time pulse being asynchronous to a clock signal;

a first address signal generator, the first address signal generator generating a first address, the first address representing the first channel, the first address signal generator generating a first address signal, the first address signal comprising the first address, the first address signal being synchronous to the clock signal; and

a first channel signal generator, the first channel signal generator generating a first channel signal, the first channel signal comprising the first time signal and the first address signal, the first channel signal generator outputting the first channel signal serially.

12. An apparatus to serially transfer annihilation information in a compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 11, further comprising:

a second time signal generator, the second time signal generator inputting a second time pulse on a second channel, the second channel being one of the plurality of channels, the second time pulse comprising a position representing a time-of-occurrence of a second annihilation event, the second time signal generator generating a second time signal, the second time signal representing a time-of-occurrence of the second time pulse, the second time pulse being asynchronous to the clock signal;

a second address signal generator, the second address signal generator generating a second address, the second address representing the second channel, the second address signal generator generating a second address signal, the second address signal comprising the second address, the second address signal being synchronous to the clock signal; and

a second channel signal generator, the second channel signal generator generating a second channel signal, the second channel signal comprising the second time signal and the second address signal, the second channel signal generator generating a composite signal, the composite signal comprising the first channel signal and the second channel signal, the second channel signal generator outputting the composite signal serially.

13. An apparatus to serially transfer annihilation information in a compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 11, wherein the first time signal generator inputs a second time pulse on a second channel, the second channel being one of the plurality of channels, the second time pulse comprising a position representing a time-of-occurrence of a second annihilation event, the first time signal generator generating a second time signal, the second time signal representing a time-of-occurrence of the second time pulse, the second time pulse being asynchronous to the clock signal, the first address signal generator generating a second address, the second address representing the second channel, the first address signal generator generating a second address signal, the second address signal comprising the second address, the second address signal being synchronous to the clock signal, the first channel signal generator generating a second channel signal, the second channel signal comprising the second time signal and the second address signal, the first channel signal generator generating a composite signal, the composite signal comprising the first channel signal and the second channel signal, the first channel signal generator outputting the composite signal serially.

14. An apparatus to serially transfer annihilation information in a compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 11, wherein the apparatus is adapted for use in obtaining the input function from least one of a human wrist, head, neck, arm, and leg.

15. An apparatus to serially transfer annihilation information in a compact positron emission tomography (PET) scanner used to obtain an input function from at

least a portion of a human body as defined by Claim 11, further comprising a first energy signal generator, the first energy signal generator inputting first energy information on the first channel, the first energy information comprising an energy content of the first annihilation event, the first energy signal generator generating a first energy signal, the first energy signal comprising a first energy pulse, the first energy pulse comprising a position representing the first energy information, the first energy pulse being asynchronous to the clock signal, the first channel signal generator incorporating the first energy signal in the first channel signal.

16. An apparatus to serially transfer annihilation information in a compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 12, further comprising a second energy signal generator, the second energy signal generator inputting second energy information on the second channel, the second energy information comprising an energy content of the second annihilation event, the second energy signal generator generating a second energy signal, the second energy signal comprising a second energy pulse, the second energy pulse comprising a position representing the second energy information, the second energy pulse being asynchronous to the clock signal, the second channel signal generator incorporating the second energy signal in the second channel signal.

17. An apparatus to serially transfer annihilation information in a compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 15, wherein the first energy signal generator inputs second energy information on the first channel, the second energy information comprising an energy content of the second annihilation event, the

first energy signal generator generating a second energy signal, the second energy signal comprising a second energy pulse, the second energy pulse comprising a position representing second energy information, the second energy pulse being asynchronous to the clock signal, the first channel signal generator incorporating the second energy signal in the first channel signal.

18. An apparatus to serially transfer annihilation information in a compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 11, wherein the first channel signal generator incorporates a synchronous delay between the first time signal and the first address signal.

19. An apparatus to serially transfer annihilation information in a compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 11, wherein the first channel signal generator generates a first packet, the first packet comprising information representing the first time signal and the first address signal, the first signal generator determining a duration of the packet T_{packet} in accordance with the following equation:

$$T_{packet} = (\log_2(N) + 2) * T_{clock} \qquad (1),$$

N representing the number of channels, T_{clock} representing a period of the clock signal.

20. An apparatus to serially transfer annihilation information in a compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 11, wherein the first channel signal generator generates a first packet, the first packet comprising information representing the first time signal and the first address signal, the first channel signal

generator determining a duration of the packet T_{packet} in accordance with the following equation:

$$T_{packet} \langle\langle 1/(N * rate) \qquad (2),$$

N representing the number of channels, *rate* representing an average rate of annihilation events per channel.

21. An apparatus to serially transfer annihilation information in a compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 11, further comprising:

a second time signal generator, the second time signal generator inputting a second time pulse on a second channel, the second channel being one of the plurality of channels, the second time pulse comprising a position representing a time-of-occurrence of a second annihilation event, the time-of-occurrence of the first annihilation event being substantially the same as the time-of-occurrence of the second annihilation event; and

a priority encoder, the priority encoder disregarding one of the first annihilation event and the second annihilation event in accordance with a priority scheme.

22. An apparatus to serially transfer annihilation information in a compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 11, further comprising:

a second time signal generator, the second time signal generator inputting a second time pulse on a second channel, the second channel being one of the plurality of channels, the second time pulse comprising a position representing a time-of-occurrence of a second annihilation event, the time-of-occurrence of the first

annihilation event being substantially the same as the time-of-occurrence of the second annihilation event; and

a priority encoder, the priority encoder disregarding one of the first annihilation event and the second annihilation event associated with a lower channel address.

23. An apparatus to serially transfer annihilation information in a compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 11, wherein the apparatus is adapted for implementation in an Application Specific Integrated Circuit (ASIC).

24. An apparatus to serially transfer annihilation information in a compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 11, wherein the first time signal generator comprises a flip-flop, the flip flop being clocked by the first time pulse, the flip flop outputting the first time signal.

25. An apparatus to serially transfer annihilation information in a compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 11, wherein the first address signal generator comprises a shift register, the shift register being loaded with the first address in response to the first time signal, the shift register being clocked by the clock signal.

26. An apparatus to serially transfer annihilation information in a compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 11, wherein the first channel

signal generator comprises combinatorial logic, the combinatorial logic incorporating the first time signal and the first address signal in the first channel signal.

27. A compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body, the scanner comprising:

a scintillation array, the scintillation array comprising a first crystal, the first crystal being one of a plurality of crystals in the scintillation array, the first crystal being associated with a first channel, the first crystal outputting at least one photon in response to receiving gamma radiation from a first annihilation event;

a detection array, the detection array comprising a first detector, the first detector being one of a plurality of detectors in the detection array, the first detector being associated with the first channel, the first detector outputting a first detection signal in response to detecting the at least one photon;

a front-end array, the front end array comprising a first front end, the first front end being one of a plurality of front ends in the front end array, the first front end being associated with the first channel, the first front end outputting a first time pulse in response to receiving the first detection signal;

a first serial encoder, the first serial encoder being associated with the first channel, the first serial encoder comprising:

a first time signal generator, the first time signal generator inputting the first time pulse on the first channel, the first channel being one of a plurality of channels, the first time pulse comprising a position representing a time-of-occurrence of a first annihilation event, the first time signal generator generating a first time signal, the first time signal representing a time-of-occurrence of the first time pulse, the first time pulse being asynchronous to a clock signal;

a first address signal generator, the first address signal generator generating a first address, the first address representing the first channel, the first address signal generator generating a first address signal, the first address signal comprising the first address, the first address signal being synchronous to the clock signal; and

a first channel signal generator, the first channel signal generator generating a first channel signal, the first channel signal comprising the first time signal and the first address signal, the first channel signal generator outputting the first channel signal serially.

28. A compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 27, further comprising a second serial encoder, the second serial encoder being associated with a second channel, the second serial encoder comprising:

a second time signal generator, the second time signal generator inputting a second time pulse on the second channel, the second channel being one of the plurality of channels, the second time pulse comprising a position representing a time-of-occurrence of a second annihilation event, the second time signal generator generating a second time signal, the second time signal representing a time-of-occurrence of the second time pulse, the second time pulse being asynchronous to the clock signal;

a second address signal generator, the second address signal generator generating a second address, the second address representing the second channel, the second address signal generator generating a second address signal, the second

address signal comprising the second address, the second address signal being synchronous to the clock signal; and

a second channel signal generator, the second channel signal generator generating a second channel signal, the second channel signal comprising the second time signal and the second address signal, the second channel signal generator generating a composite signal, the composite signal comprising the first channel signal and the second channel signal, the second channel signal generator outputting the composite signal serially.

29. A compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 27, wherein the first time signal generator inputs a second time pulse on a second channel, the second channel being one of the plurality of channels, the second time pulse comprising a position representing a time-of-occurrence of a second annihilation event, the first time signal generator generating a second time signal, the second time signal representing a time-of-occurrence of the second time pulse, the second time pulse being asynchronous to the clock signal, the first address signal generator generating a second address, the second address representing the second channel, the first address signal generator generating a second address signal, the second address signal comprising the second address, the second address signal being synchronous to the clock signal, the first channel signal generator generating a second channel signal, the second channel signal comprising the second time signal and the second address signal, the first channel signal generator generating a composite signal, the composite signal comprising the first channel signal and the second

channel signal, the first channel signal generator outputting the composite signal serially.

30. A compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 27, wherein the first front end further comprises at least one of a preamplifier, a shaper network, a zero-crossing detector, and a constant fraction discriminator.

31. A compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 27, wherein the scanner is adapted for use in obtaining the input function from at least one of a human wrist, head, neck, arm, and leg.

32. A compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 27, wherein the first serial encoder further comprises a first energy signal generator, the first energy signal generator inputting first energy information on the first channel, the first energy information comprising an energy content of the first annihilation event, the first energy signal generator generating a first energy signal, the first energy signal comprising a first energy pulse, the first energy pulse comprising a position representing the first energy information, the first energy pulse being asynchronous to the clock signal, the first channel signal generator incorporating the first energy signal in the first channel signal.

33. A compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 28, wherein the second serial encoder further comprises a second energy signal generator, the second energy signal generator inputting second energy information on the second

channel, the second energy information comprising an energy content of the second annihilation event, the second energy signal generator generating a second energy signal, the second energy signal comprising a second energy pulse, the second energy pulse comprising a position representing the second energy information, the second energy pulse being asynchronous to the clock signal, the second channel signal generator incorporating the second energy signal in the second channel signal.

34. A compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 32, wherein the first energy signal generator inputs second energy information on a second channel, the second energy information comprising an energy content of a second annihilation event, the first energy signal generator generating a second energy signal, the second energy signal comprising a second energy pulse, the second energy pulse comprising a position representing the second energy information, the second energy pulse being asynchronous to the clock signal, the first channel signal generator incorporating the second energy signal in the first channel signal.

35. A compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 27, wherein the first channel signal generator generates a first packet, the first packet comprising information representing the first time signal and the first address signal, the first channel signal generator determining a duration of the packet T_{packet} in accordance with the following equation:

$$T_{packet} \langle\langle 1/(N * rate) \qquad (2),$$

N representing the number of channels, *rate* representing an average rate of annihilation events per channel.

36. A compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 27, further comprising:

a second serial encoder, the second serial encoder being associated with a second channel, the second serial encoder comprising a second time signal generator, the second time signal generator inputting a second time pulse on a second channel, the second channel being one of the plurality of channels, the second time pulse comprising a position representing a time-of-occurrence of a second annihilation event, the time-of-occurrence of the first annihilation event being substantially the same as the time-of-occurrence of the second annihilation event; and

a priority encoder, the priority encoder disregarding one of the first annihilation event and the second annihilation event in accordance with a priority scheme.

37. A compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 27, further comprising:

a second serial encoder, the second serial encoder being associated with a second channel, the second serial encoder comprising a second time signal generator, the second time signal generator inputting a second time pulse on a second channel, the second channel being one of the plurality of channels, the second time pulse comprising a position representing a time-of-occurrence of a second annihilation event, the time-of-occurrence of the first annihilation event being substantially the same as the time-of-occurrence of the second annihilation event; and

a priority encoder, the priority encoder disregarding one of the first annihilation event and the second annihilation event associated with a lower channel address.

38. A compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 27, wherein the front-end array and the first serial encoder are adapted for implementation in an Application Specific Integrated Circuit (ASIC).

39. A compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 27, wherein the scintillation array comprises at least one Lutetium Oxyorthosilicate (LSO) crystal.

40. A compact positron emission tomography (PET) scanner used to obtain an input function from at least a portion of a human body as defined by Claim 27, wherein the detector array comprises at least one avalanche photodiode (APD).